CIRCUIT BOARD AND ITS MANUFACTURING METHOD

FIELD OF THE INVENTION

The present invention relates to a circuit board with a conductive circuit, and a circuit board equipped with a resistor, capacitor and semiconductor integrated circuit element or the like, and its manufacturing method.

BACKGROUND OF THE INVENTION

Recently, there is a great demand for miniaturization of electronic equipment such as cellular phones in particular, and circuit boards built into electronic equipment are also required to be smaller, thinner, and higher in mounting density. For example, in Japanese Laid-open Patent 2001-53413, disclosed is a method of manufacturing electronic part built-in boards in which electronic parts are mounted by coating electronic parts in such manner as to expose the connection of at least one electronic part and forming a metallic pattern on the resin surface including the exposed connection. Further, a method of manufacturing a multilayer electronic part built-in board by laminating the boards is also disclosed. By using such configuration, it is possible to greatly reduce the size and to improve the mounting density as claimed in the invention.

Further, in Japanese Laid-open Patent 2001-93934, disclosed is a method of forming a circuit pattern with use of conductive paste on the pattern formed surface of the substrate including the circuit connection, inserting semiconductor integrated

circuit element in a substrate and exposing the circuit connections of the semiconductor integrated circuit element on the pattern formed surface of the substrate. Thus, it is possible to prevent semiconductor integrated circuit element from sinking into the substrate without using anisotropic conductive resin in mounting, to improve the productivity and to lower the cost, and further, to prevent the generation of defectives such as breading of circuit patterns as is claimed in the invention.

However, when a multilayer board is manufactured by such methods, same as in a conventional method of manufacturing multilayer boards, the thickness is increased because a multilayer circuit board is manufactured by laminating a plurality of circuit boards with electronic parts built-in. In case of configuring a complicated circuit board, the thickness tends to further increase because the number of laminated layers of circuit boards mounted with electronic parts is increased. Accordingly, it becomes difficult to reduce the thickness of the circuit board.

SUMMARY OF THE INVENTION

The present invention is intended to solve the above problem, and the object is to realize further reduction in size of multilayer circuit boards.

The circuit board of the present invention includes the following configuration.

A circuit board, comprising:

a base layer;

a first conductive circuit manufactured by hardening a conductive paste material formed in a predetermined shape on the base layer;

a first insulating layer manufactured by hardening an insulating paste material formed on the base layer including the first conductive circuit; and

a second conductive circuit manufactured by hardening a conductive paste material formed in a predetermined shape on the first insulating layer.

By using this configuration, a multilayer circuit structure can be realized at a relatively low temperature by using a method of applying a conductive paste material and insulating paste material. As a result, it is possible to obtain thin circuit boards using inexpensive plastic film and to laminate them into a thin and flexible board.

Further, the circuit board of the present invention can be configured as follows.

A circuit board, comprising:

a part arrangement layer with the electronic parts arranged so that the electrode terminal of electronic part with an electrode terminal formed at one surface thereof is exposed on the surface; and

a second conductive circuit electrically connected to the electrode terminal on the part arrangement layer and formed in a predetermined shape,

wherein the part arrangement layer comprises:

a first conductive circuit formed by hardening a conductive paste material formed in a predetermined shape, and

an insulating layer formed by hardening an insulating paste material applied to the first conductive circuit, which is formed in such manner that the electrode terminal of the electronic part is exposed on the surface of the insulating layer.

Due to the above configuration, it is possible to form conductive circuits or insulating layers at relatively low temperatures, and even in case electronic parts such as semiconductor integrated circuit elements are mounted, the reliability is not affected and it is possible to realize a circuit board being thin as a whole and highly reliable. Also, even with electronic parts built in, it is possible to realize a circuit board being thin as a whole.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of a base film, out of the sectional views showing the main manufacturing process of a circuit board in the first exemplary embodiment of the present invention.

Fig. 2 is a sectional view of a first conductive circuit, out of the sectional views showing the main manufacturing process of a circuit board in the first exemplary embodiment.

Fig. 3 is a sectional view of a first insulating layer, out of the sectional views showing the main manufacturing process of a circuit board in the first exemplary embodiment.

Fig. 4 is a sectional view of an electronic part inserted in a first opening, out of the sectional views showing the main

manufacturing process of a circuit board in the first exemplary embodiment.

Fig. 5 is a sectional view of a second insulating layer, out of the sectional views showing the main manufacturing process of a circuit board in the first exemplary embodiment.

Fig. 6 is a sectional view of a dielectric layer, out of the sectional views showing the main manufacturing process of a circuit board in the first exemplary embodiment.

Fig. 7 is a sectional view of a second conductive circuit, out of the sectional views showing the main manufacturing process of a circuit board in the first exemplary embodiment.

Fig. 8 is a sectional view of a reistive layer, out of the sectional views showing the main manufacturing process of a circuit board in the first exemplary embodiment.

Fig. 9 is a sectional view of a third insulating layer, out of the sectional views showing the main manufacturing process of a circuit board in the first exemplary embodiment.

Fig. 10 shows a sectional view of a completed circuit board in the first exemplary embodiment.

Fig. 11 is a flow chart showing the main manufacturing process of a circuit board in the first exemplary embodiment.

Fig. 12 is a sectional view showing a state of adhesive applied to the first opening, a diagram for describing the manufacturing process of modification of a circuit board in the first exemplary embodiment.

Fig. 13 is a diagram showing a state of electronic parts inserted in the first opening and fixed with adhesive, a diagram for

describing the manufacturing process of modification in the first exemplary embodiment.

Fig. 14 is a part of a flow chart for describing the manufacturing process of modification in the first exemplary embodiment.

Fig. 15 is a sectional view of a first conductive circuit, out of the sectional views showing the main manufacturing process of a circuit board in the second exemplary embodiment of the present invention.

Fig. 16 is a sectional view of a first insulating layer, out of the sectional views showing the main manufacturing process of a circuit board in the second exemplary embodiment.

Fig. 17 is a sectional view of an electronic part inserted in a first opening, out of the sectional views showing the main manufacturing process of a circuit board in the second exemplary embodiment.

Fig. 18 is a sectional view of a second insulating layer, out of the sectional views showing the main manufacturing process of a circuit board in the second exemplary embodiment.

Fig. 19 is a sectional view of a second conductive circuit, out of the sectional views showing the main manufacturing process of a circuit board in the second exemplary embodiment.

Fig. 20 is a sectional view of a third insulating layer, out of the sectional views showing the main manufacturing process of a circuit board in the second exemplary embodiment.

Fig. 21 is a sectional view of an electronic part inserted in the third opening, out of the sectional views showing the

main manufacturing process of a circuit board in the second exemplary embodiment.

Fig. 22 is a sectional view of the fourth insulating layer formed, out of the sectional views showing the main manufacturing process of a circuit board in the second exemplary embodiment.

Fig. 23 is a sectional view of the third conductive circuit formed, out of the sectional views showing the main manufacturing process of a circuit board in the second exemplary embodiment.

Fig. 24 is a diagram showing a sectional view of a completed circuit board in the second exemplary embodiment.

Fig. 25 is a flow chart for describing the main manufacturing process of a circuit board in the second exemplary embodiment.

Fig. 26 is a sectional view of a circuit board in the third exemplary embodiment of the present invention.

Fig. 27 is a plan view showing the connection between a part of conductive circuit and metallic wiring, a diagram for describing the modification of a conductive circuit used in the present invention.

Fig. 28 is a sectional view of a circuit board having a laminated configuration of a circuit board and a plate member, a diagram for describing the modification of a conductive circuit of the present invention.

Fig. 29 is a sectional view of a circuit board having a laminated configuration of plate members with a circuit board bonded therebetween in the first exemplary embodiment of the present invention.

Fig. 30 is a sectional view showing another modification

of a circuit board in the first exemplary embodiment of the present invention.

Fig. 31 is a sectional view showing further another modification of a circuit board in the first exemplary embodiment of the present invention.

Fig. 32 is a sectional view of a circuit board with base film protruded in the circuit board shown in Fig. 29.

Fig. 33 is a sectional view of a circuit board with base film protruded, circuit formed on the protruded region, and electronic part mounted thereon in the circuit board shown in Fig. 29.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENT

The circuit board and its manufacturing method of the present invention will be described in detail in the following with reference to the drawings. Incidentally, like reference numerals refer to like component elements in the drawings.

FIRST EXEMPLARY EMBODIMENT

Fig. 1 to Fig. 9 show sectional views of circuit board 1 in major manufacturing steps in the first exemplary embodiment of the present invention. Fig. 10 shows a sectional shape of completed circuit board 1. Also, Fig. 11 is a flow chart of the manufacturing process of the present exemplary embodiment. The circuit board 1 of the present exemplary embodiment shown in Fig. 10 is just an example. It is preferable to execute the steps of Fig. 1 to Fig. 9 a plurality of times and to omit unnecessary

steps.

When the circuit board 1 is manufactured, as shown in Fig. 1, a base film of about 100 μm thick is used as a base layer. In the present exemplary embodiment, the base layer is described as base film 11 in the following. As the base film 11, it is desirable to use polyethylene telephthalate (PET) resin, acrylonitrile-butadiene styrene (ABS) resin or polycarbonate resin, but it is also possible to use resin of being relatively high in heat resistance such as polyimide resin.

Next, as shown in Fig. 2, first conductive circuit 13 is formed by heating and hardening a wiring pattern of conductive paste material such as silver paste printed on the base film 11 by means of screen printing or offset printing (step S11).

The silver paste is a mixture of thermosetting and heat shrinking resin and silver powder, and when the silver paste is heated after printing, the resin hardens and shrinks, and thereby, the first conductive circuit 13 can be formed.

Next, as shown in Fig. 3, insulating paste material is printed on the base film 11 including the first conductive circuit 13 by means of a screen printing process or the like, and the paste is heated and hardened to form first insulating layer 15 (step S12). In this case, the first insulating layer 15 is not printed on predetermined portions of the first conductive circuit 13. These predetermined portions correspond to via 310, connection opening for electrical connection with second conductive circuit 19 to be formed later, and second opening 330 for forming a conductive paste material. Also, when

the first insulating layer is formed, first opening 320 for inserting electronic part 4 is formed in the base film 11.

Subsequently, as shown in Fig. 4, the electronic part 4 is inserted in such manner as to bury it into the first opening 320 (step S13). As the electronic part 4, for example, it is desirable to use a semiconductor integrated circuit element (bare chip IC) of bare chip configuration, and it is preferable to have a bump as electrode terminal 41 as shown in Fig. 4. The electronic part 4 is inserted in such manner that the electrode terminals 41 are positioned at the side opposite to the base film 11, that is, the surface opposite to the electrode terminals 41 are in contact with the base film 11. As the electronic part 4, it is preferable to use a semiconductor integrated circuit element (package IC) of package configuration as well as bare chip IC. Further, it is also preferable to use a chip type electronic part such as a resistor and capacitor or multiple chip type electronic parts including a plurality of these parts.

Next, as shown in Fig. 5, an insulating paste material is printed on the first insulating layer 15 formed and the electronic part 4 inserted by means of a screen printing process or the like, and the paste is heated and hardened to form second insulating layer 17 (step S14). In this case, the paste is not printed on the via 310 and the second opening 330 of the first insulating layer 15, and also nearly only the surface of the electrode terminals 41 of the electronic part 4 is exposed on the second insulating layer 17. In this way, the electronic part 4 is buried in the second insulating layer 17 as a whole. In

order to prevent the electronic part 4 from being damaged, the insulating paste materials used are desirable to harden at 120°C or lower, and more preferably, at 110°C or lower.

Subsequently, as shown in Fig. 6, dielectric paste material is applied to the second opening 330, followed by heating and hardening (step S15). In this way, dielectric layer 51 is formed in the second opening 330. It is also preferable to execute heating and hardening of the dielectric paste material simultaneously with heating and hardening of the second insulating layer 17.

Next, as shown in Fig. 7, conductive paste material composed of silver paste is printed on the second insulating layer 17 and the dielectric layer 51 by screen printing or the like, followed by heating and hardening to form the second conductive circuit 19 (step S16). In this case, as shown in Fig. 6 and Fig. 7, the silver paste is formed in the via 310 as well, and therefore, the first conductive circuit 13 and the second conductive circuit 19 are electrically connected to each other through the via 310. Thus, it is possible to form the second conductive circuit 19 and to connect it to the first conductive circuit 13 through the via 310 at the same time. Accordingly, the manufacturing process can be simplified. Also, by printing the paste in such manner as to make connection with the electrode terminals 41 of the electronic part 4, it is possible to obtain the second conductive circuit 19 which is also connected with the electrode terminals 41 of the electronic part 4.

Further, simultaneously with printing, generally spiral or

meandering pattern is formed on the second conductive circuit 19, followed by heating and hardening to form inductor 191. In the case of an inductor having a spiral pattern, one of the electrodes can be connected to the first conductive circuit 13. Also, as a result of forming the second conductive circuit 19, both surfaces of the dielectric layer 51 in the direction of its thickness are sandwiched between the first conductive circuit 13 and the second conductive circuit 19. Therefore, capacitor 61 is configured with the conductor of first conductive circuit 13, dielectric layer 51, and the conductor of second conductive layer 19.

In the above process, in order to prevent the electronic part 4 from being damaged, it is desirable to use conductive paste material which hardens at 120°C or lower, and more preferably, at 110°C or lower. The first insulating layer 15 and the second insulating layer 17 serve to electrically connect the first conductive circuit 13 to the second conductive circuit 19 except the portion of via 310.

The second conductive circuit 19 is further provided with gap 22. As shown in Fig. 8, resistant paste material is applied to the gap 22. And, the resistant paste material is heated and hardened to form resistive layer 52. Each end of the reistive layer 52 in the gap 22 is electrically connected with the conductor of first conductive circuit 13, thereby configuring resistor 71 (step S17). It is preferable to execute heating and hardening of the resistance paste material simultaneously with heating and hardening of the second conductive circuit 19.

Next, as shown in Fig. 9, insulating paste material is printed on the second conductive circuit 19, resistor 71 and the second insulating layer 17 by screen printing or the like, followed by heating and hardening to form third insulating layer 23 (step S18). The third insulating layer 23 is provided with via 340 as needed that is connection opening where the second conductive circuit 19 is exposed.

Finally, as shown in Fig. 10, electronic parts, for example chip type electronic parts 6 such as resistors and capacitors, are mounted on the third insulating layer 23. As to these chip type electronic parts 6, the second conductive circuit 19 and the electrode of the chip type electronic parts 6 are electrically connected to each other through via 340 by means of solder or conductive bonding agent (step S19). It is preferable to mount a connector or the like used to install the circuit board 1 in electronic equipment (not shown) through the via 340.

According to the above process, the circuit board 1 in the present exemplary embodiment can be manufactured. In the case of circuit board 1 of the present exemplary embodiment, the first conductive circuit 13, the second conductive circuit 19, the first insulating layer 15, the second insulating layer 17, and the third insulating layer 23 are formed by using conductive paste material and insulating paste material, which are laminated to obtain a multilayer circuit structure. As a result, it is possible to thin the structure as a whole. Also, since a circuit structure is formed on the base film 11, it has

excellent flexibility and can be used as a circuit board furnished with functional elements for various types of electronic equipment.

As the circuit board 1 of the present exemplary embodiment, besides the configuration shown in Fig. 10, it is preferable to finally remove the base film 11 before using. In this way, a circuit board more reduced in size can be realized. When using such a configuration, it is not necessary to use a base film as described in the present exemplary embodiment, but preferable to use a plate member. As such the plate member, it is desirable to use the plate member which is easy to remove being less in adhesion to materials for forming conductive circuits such as silver paste and materials for forming insulating layers.

Also, since the circuit board of the present exemplary embodiment is manufactured by forming conductive paste material and insulating paste material with use of application methods including a printing system and repeating the steps of heating and hardening, circuit boards equipped with various types of electronic parts can be easily manufactured.

Also, as for the first conductive circuit 13, the second conductive circuit 19, the first insulating layer 15, the second insulating layer 17, and the third insulating layer 23, complicated circuits can be manufactured without giving damage to the built-in electronic part 4 by using materials which harden at relatively low temperatures.

Further, in the circuit board 1 of the present exemplary embodiment, inductor 191 is disposed on the second conductive

circuit 19, capacitor 61 is disposed by holding the dielectric layer 51 between the first conductive circuit 13 and the second conductive circuit 19, and resistor 71 is disposed by forming the reistive layer 52 in the gap 22 of the second conductive circuit 19. Accordingly, it is possible to obtain the circuit board 1 having complicated circuits with excellent function while realizing the reduction in thickness.

The circuit board 1 shown in Fig. 10 is just an example, and it is preferable to dispose the inductor 191 on the first conductive circuit 13 and to dispose the reistive layer 52 in a gap formed in the first conductive circuit 13.

Further, it is possible to form a reistive layer by heating and hardening a resistance paste material applied to the second opening 330. In this case, a reistive layer is formed between the first conductive circuit 13 that is the lower layer and the second conductive circuit 19 that is the upper layer, thereby forming resistor in the vertical direction. Also, it is possible to heat and harden the dielectric paste material applied to the gap 22 formed in the second conductive circuit 19 to form a dielectric layer thereon. In this case, a capacitor is formed in the horizontal direction because the second conductive circuits 19 connected to the dielectric layer serve as electrodes respectively at both sides being flush with each other. Thus, in the flow chart shown in Fig. 11, it is possible to freely form a dielectric layer and reistive layer by properly changing the paste material in step S15 and step S17.

Fig. 12 and Fig. 13 are diagrams for describing the method

of manufacturing modifications of a circuit board in the present exemplary embodiment. The manufacturing method of the present exemplary embodiment additionally includes a step of applying adhesive to the bottom of the first opening 320 between step S12 and step S13 described in the first exemplary embodiment, making it a method of bonding the electronic part 4 beforehand, and this point differs from the first exemplary embodiment. Fig. 14 is a part of the flow chart additionally including a step of "applying adhesive to the first opening" that is step 21 between step 12 and step 13.

In the circuit board of this modification, the first opening 320 is formed the same as in the first exemplary embodiment. This is identical with the shape shown in Fig. 3 (step 12). Subsequently, as shown in Fig. 12, adhesive 53 is applied to the first opening 320 (step 21). After that, as shown in Fig. 13, the electronic part 4 is inserted into the first opening 320 in such manner that the surface at the opposite side of the electrode terminals 41 are opposed to the base film 11, which is then secured with adhesive 53 (step S13). The steps thereafter are same as in the first exemplary embodiment, and the description is omitted.

Thus, even when the shape of the first opening 320 is poor in accuracy, the electronic part 4 can be correctly secured in the predetermined position. In that case, even when the first opening 320 becomes larger than the electronic part 4, causing a gap to be created between the first opening 320 and the electronic part 4, the gap will be filled with the second

insulating layer 17 to be formed later. Accordingly, even in case a plurality of electronic parts 4 including relatively many electrode terminals 41 are mounted, the positional deflection of electronic parts 4 from each other can be lessened, and therefore, forming the second conductive circuit 19 by printing or the like will not cause shorting trouble or the like. This is effective especially in the case of using bare chip IC as electronic part 4 and a large number of electrode terminals 41.

SECOND EXEMPLARY EMBODIMENT

Fig. 15 to Fig. 24 show the sectional views of main manufacturing processes of circuit board 100 in the second exemplary embodiment of the present invention. Fig. 24 is a sectional shape of completed circuit board 100. Also, Fig. 25 is a flow chart of the manufacturing processes of the present exemplary embodiment. The manufacturing processes of the circuit board 100 of the present exemplary embodiment are same as in the first exemplary embodiment except that the manufacture of resistors, capacitors and inductors is omitted in the first half of the processes, and like reference numerals refer to like component elements.

First, the base film 11 as a base layer is prepared the same as in the first exemplary embodiment. As shown in Fig. 15, a predetermined wiring pattern is formed on the base film 11 by means of a screen printing process or the like with use of silver paste that is a conductive paste material, which is heated and hardened to form the first conductive circuit 202 (step S31).

Next, as shown in Fig. 16, conductive paste material is printed on the base film 11 including the first conductive circuit 202 by means of a screen printing process or the like, which is heated and hardened to form the first insulating layer 302 (step S32). In this case, via 310 is formed in the first insulating layer 302 so that a part of the first conductive circuit 202 is exposed. At the same time, the first opening 322 and the third opening 324 for inserting electronic parts are formed in the first insulating layer 302 on the base film 11.

Subsequently, as shown in Fig. 17, electronic part 400 is inserted into the first opening 322 (step S33). In this case, the electronic part 400 is inserted in such manner that the surface at the opposite side of the electrode terminals 410 formed on one surface of the electronic part 400 comes in contact with the base film 11. Also in the present exemplary embodiment, bare chip IC having electrode terminals 410 with bumps formed thereon is used as the electronic part 400.

Next, as shown in Fig. 18, the second insulating layer 304 is formed so as to cover the surface of electronic part 400 except the electrode terminals 410 and the surface of the first insulating layer 302. The second insulating layer 304 is formed by screen printing or the like of insulating paste material, followed by heating and hardening (step S34). In this case, the insulating paste material is not printed on the via 310 and the third opening 324 formed in the first insulating layer 302, leaving the surfaces intact. As a result, the via 310, the third opening 324, and the electrode terminals 410 of electronic part

400 are in a state of being exposed on the second insulating layer 304. In this condition, the first conductive circuit 202, the first insulating layer 302, and the second insulating layer 304 configure part arrangement layer 200 in relation to the electronic part 400.

After the second insulating layer 304 is formed on the electronic part 400, as shown in Fig. 19, a predetermined wiring pattern is printed on the second insulating layer 304, which is heated and hardened to form the second conductive circuit 204. The second conductive circuit 204 is formed by a screen printing process or the like with use of silver paste that is a conductive paste material (step S35). In this case, since the silver paste material is also applied to the via 310, the first conductive circuit 202 of the lower layer and the second conductive circuit 204 of the upper layer are electrically connected with each other. Further, the electrode terminals 410 of electronic part 400 are also electrically connected to each other by the second conductive circuit 204. The first insulating layer 302 and the second insulating layer 304 serve to electrically insulating the first conductive circuit 202 of the lower layer from the second conductive circuit 204 of the upper layer at portions except the via 310.

Next, as shown in Fig. 20, the third insulating layer 306 is formed on the second conductive circuit 204 and the second insulating layer 304 which are the upper layers. The third insulating layer 306 is also formed by screen printing or the like of insulating paste material, followed by heating and

hardening (step S36). In this case, via 312 is properly formed in the third insulating layer 306 as needed to meet the circuit design requirement.

The above steps are nearly the same as those of the manufacturing method in the first exemplary embodiment. Through the steps, the electronic part 400 is connected by the second conductive circuit 204, and a circuit board of multilayer configuration built in by a plurality of insulating layers can be obtained. In the present exemplary embodiment, another electronic part 402 is further mounted in the third opening 324.

As shown in Fig. 21, another electronic part 402 is inserted into the third opening 324 (step S37). Also in the case of the electronic part 402, same as in the electronic part 400 initially mounted, it is inserted in such manner that the surface at the opposite side of the electrode terminals 412 formed on one surface thereof comes in contact with the base film 11. The another electronic part 402 is required to be larger in thickness as compared with the initial electronic part 400. Therefore, when bare chip IC is used, it should be thicker than the electronic part 400. Also, package IC or the like is to be used.

After that, as shown in Fig. 22, fourth insulating layer 308 is formed on the surface of the electronic part 402 except electrode terminals 412 and the surface of the third insulating layer 306. The fourth insulating layer 308 is also formed by screen printing or the like of an insulating paste material, followed by heating and hardening (step S38). In this case, the via 312 formed in the third insulating layer 306 is left intact,

and the electrode terminals 412 of electronic part 402 is exposed on the fourth insulating layer 308. In this condition, the layers including the second conductive circuit 204, the third insulating layer 306 and the fourth insulating layer 308, in addition to the first conductive circuit 202, the first insulating layer 302 and the second insulating layer 304 configuring the part arrangement layer 200 described above, configure part arrangement layer 250 in relation to the electronic part 402.

After the fourth insulating layer 308 is formed on the electronic part 402, the third conductive circuit 206 is formed on the fourth insulating layer 308 as shown in Fig. 23. The third conductive circuit 206 is also formed by screen printing or the like of silver paste being a conductive paste material, followed by heating and hardening (step S39). In this case, since the silver paste is applied to the via 312 as well, the second conductive circuit 204 and the third conductive circuit 206 are electrically connected with each other. Further, the electrode terminals 412 of electronic part 402 are electrically connected to each other. The third insulating layer 306 and the fourth insulating layer 308 serve to electrically insulating the second conductive circuit 204 from the third conductive circuit 206 at portions except the via 312.

Next, as shown in Fig. 24, the fifth insulating layer 309 is formed on the third conductive circuit 206 and the fourth insulating layer 308. The fifth insulating layer 309 is also formed by screen printing or the like of insulating paste

material, followed by heating and hardening (step S40). The fifth insulating layer 309 is provided with via 342 for making the third conductive circuit 206 exposed at predetermined portions according to the circuit design. The via 342 is also used as an electrode for connection when another electronic part such as chip type electronic part (not shown) is mounted or circuit board 100 is built into electronic equipment (not shown). Incidentally, shown in Fig. 24 is circuit board 100 whose configuration includes no chip type electronic part or the like.

Also, in the present exemplary embodiment, the manufacturing steps of resistors, capacitors and inductors are not illustrated, and the description is omitted, but it is possible to manufacture the parts according to the same steps as in the first exemplary embodiment.

As described above, in the circuit board of the present exemplary embodiment, electronic parts 400, 402 different in thickness are disposed in the respective part arrangement layers, and the electrode terminals are connected to the respective conductive circuits. Accordingly, a multilayer circuit is formed in the prescribed thickness with the electronic part 402 greater in thickness, and the electronic parts 400, 402 are also mounted. Consequently, it is possible to make the circuit board 100 thinner and higher in density. Also, since the flexibility is maintained due to such reduction in thickness of the circuit board, it becomes possible to bend and install the circuit board in electronic equipment as needed.

In the circuit board 1 of the first exemplary embodiment,

a base layer is the base film 11, and conductive circuits are formed in multiple layers on the base film 11. On the other hand, in the circuit board of the second exemplary embodiment, the base film 11 serves as a base layer foundation against the first conductive circuit 202 and the second conductive circuit 204, while the second insulating layer 304 serves as a base layer against the second conductive circuit 204 and the third conductive circuit 206. That is, supposing a relative base layer against a multilayer conductive circuit, a complicated multilayer structure can be formed by repeating the operation of forming a multilayer conductive circuit on the basis of a base layer.

Also, the same as in the first exemplary embodiment, it is preferable to remove the base film 11 after forming all the layers. Further, when the electronic parts are inserted into the first opening and the second opening, it is preferable to previously apply adhesive into these openings so that the electronic parts are secured on the base film 11 by the adhesive.

THIRD EXEMPLARY EMBODIMENT

Fig. 26 is a diagram showing the sectional shape of circuit board 700 in the third exemplary embodiment of the present invention. Also in the case of the circuit board 700 of the present exemplary embodiment, base film 702 is used as a base layer, but it is required to be thicker enough to mount electronic parts as compared with the first exemplary embodiment and the second exemplary embodiment. It is configured in that a

multilayer circuit is formed on both sides of the base film 702 with use of conductive paste material and insulating paste material and that electronic part 802 is also built in the base film 700.

The manufacturing method for the circuit board 700 of the present exemplary embodiment will be described in the following.

First, the electronic part 802 is press-fitted in the base film 702. In the press-fitting step, the electronic part 802 is press-fitted in the base film 702 from the electrode terminals 8021 side formed on one surface of the electronic part 802, and the electrode terminals 8021 is exposed at least from the surface of the base film 702. Accordingly, the base film 702 is required to be thick and plastic such that the electronic part 802 may be press-fitted therein. For example, using PET resin film, the PET resin film is previously heated and then the electronic part 802 can be easily press-fitted therein. Also, as the electronic part 802, it is desirable to use a part of relatively low in height such as IC or the like of bare chip IC and chip size package (CSP) configuration.

Next, a conductive paste material is printed on both surfaces of base film 702 by means of a screen printing process or the like, followed by heating and hardening to form the conductive circuit 704. After that, further on these both surfaces, the conductive circuit 704 and insulating layer 708 are laminated by same manufacturing method as in the first exemplary embodiment and the second exemplary embodiment, thereby forming a circuit structure of multilayer configuration.

In this case, same as in the first exemplary embodiment and the second exemplary embodiment, electronic part 804 is inserted and buried, capacitors 720, 722, 724, resistor 730, and inductor 728 are formed on predetermined portions as many as needed. In the present exemplary embodiment, an example of using bare chip IC having electrode terminals 8041 with bump formed thereon is shown as the electronic part 804. Also, the capacitors 720, 722, 724 are formed in layers different in thickness respectively, and the capacitor 724 is especially formed over a wide area and has a large capacity.

In the circuit board 700 of the present exemplary embodiment, there is provided a heat dissipating layer 706 for efficiently dissipating the heat internally generated, which is however not needed when the heat to be dissipated is not so much in quantity. The heat dissipating layer 706 can be formed for example by coating insulating paste mixed with alumina powder of high heat conductivity, and is also used as an insulating layer.

Further, in the circuit board 700 of the present exemplary embodiment, besides the built-in via 710, through-electrode 712 which goes through each layer including the base film 702 is also formed.

On the outermost surface, chip type electronic part 808 being an electronic part and electronic part 806 comprising package IC such as chip size package (CSP) and ball grid array (BGA) are connected by conductive adhesive or anisotropic conductive resin or the like between the respective connections and predetermined portions of the conductive circuit. Also, these

are secured by insulating adhesive as needed. In the present exemplary embodiment, the electronic part 806 is a package IC of BGA configuration, and balls that are electrode terminals 8061 are formed one surface thereof.

Further, after mounting these parts, sealing film 714 is formed to complete the circuit board 700 of the present exemplary embodiment.

As described above, it is possible to easily obtain circuit boards having various structures by using conductive paste material and insulating paste material.

In the first exemplary embodiment through the third exemplary embodiment, the conductive circuit is formed by printing a conductive paste material, but it is preferable to employ other manufacturing method for a part of the conductive circuit. Fig. 27 is a plan view of the connection between partial pattern 500 of conductive circuit and metallic wiring 520, illustrating the configuration of connection of the conductive circuit to the metallic wiring formed by any one of depositing, plating and sputtering processes. The partial pattern 500 of the conductive circuit formed by screen printing or the like of a conductive paste material is connected to the metallic wiring 520 formed by metal material such as copper (Cu) and aluminum (Al). The configuration shown in Fig. 27 is formed in the region to which the electronic part 4 is connected, for example, in the second conductive circuit 19 of the circuit board 1 shown in Fig. 10. Or, it is formed as a part of the second conductive circuit 204 or the third conductive circuit 206 for

connecting the electronic parts 400, 402 of the circuit board 100 shown in Fig. 24.

The metallic wiring 520 shown in Fig. 27 is mainly used for connecting the electrode terminals 41, 410, 412 of the electronic parts 4, 400, 402 to the second conductive circuits 19, 204 and the third conductive circuit 206 respectively when the pitch between the electrodes of the electrode terminals 41, 410, 412 of the electronic parts 4, 400, 402 is very fine, for example, when the electrode pitch is 50 μm or less. That is, even in case the pitch is very fine, a highly accurate pattern can be formed by forming the metallic wiring 520 by means of a depositing, plating or sputtering process. Also, for the other portions, it can be formed by a printing process with use of a conductive paste material. In this way, even when a fine pitch that is difficult to realize by using a conductive paste material is required, it is possible to manufacture circuit boards 1, 100 without difficulty.

The modifications of circuit boards 1, 100 of the present invention will be further described in the following with reference to the drawings.

Fig. 28 is a sectional view of circuit board 750 of laminated configuration wherein plate member 900 made of resin is bonded to the circuit board 1 of the first exemplary embodiment. The plate member 900 is formed with circuit 902 and is also mounted with electronic part 810. That is, the plate member 900 itself formed a circuit board. Also, the plate member 900 is formed with through-electrode 904 that connects with the circuit 902.

On the other hand, the base film 11 is also formed with through-electrode 111. The through-electrode 111 can be formed, for example, together with the first conductive circuit 13. As the through-electrode 111 on the base film 11 is opposed and bonded to the through-electrode 904 of the plate member 900, making them conducting to each other, the conductive circuit 13 on the base film 11 is electrically connected to the circuit 902 of the plate member 900. Thus, it is possible to realize a large-scale circuit board 750 wherein the circuit 902 and electronic part 810 formed on the plate member 900 are integrated with the circuit 902 of the base film 11. As the electronic part 810, it is also preferable to use a chip type electronic part or the like such as a resistor and capacitor as well as bare chip IC and package IC. Also, there are no particular limitations on the number of parts mounted.

It is also preferable to manufacture a multilayer structure by the manufacturing method described in the first exemplary embodiment and the second exemplary embodiment on one of the surfaces, using the plate member 900 instead of using the base film 11. In this case, on the plate member 900 is formed a circuit furnished with electronic parts in multilayer configuration with use of conductive paste material or insulating paste material. In the case of a circuit board of such configuration, the circuit board is rather poor in flexibility, but it is possible to reduce the thickness relatively easily even in case of realizing a similar scale of circuit as compared with a method of laminating a plurality of circuit boards as in prior art.

Fig. 29 is a sectional view of circuit board 755 of both-side laminated configuration wherein plate members 900, 910 made of resin are bonded to either side of the circuit board structure of the first exemplary embodiment. The plate members 900, 910 are formed with the circuits 902, 912 respectively. Further, one plate member 900 is mounted with the electronic part 810. Also, the other plate member 910 is mounted with the chip type electronic part 6 that is an electronic part. In the present exemplary embodiment, the electronic part 810 is bare chip IC or package IC, and the chip type electronic part 6 is a resistor or capacitor. The chip type electronic part 6 is also included in the electronic parts, but it is handled separately for the convenience of description. Namely, in the circuit board 755 shown in Fig. 29, the circuits formed by conductive paste material and insulating paste material, and the electronic parts 4 built into these circuits are held between two sheets of plate members 900, 910, thereby realizing a larger-scale circuit board 755.

Fig. 30 is a sectional view showing further another modification of the circuit board 1 of the first exemplary embodiment. The circuit board 760 of this modification is characterized in that there is provided an insulated layer at a part of the base film 11 or a region where the multilayer circuit is not formed. That is, a part of the base film 11 is projected in a tongue-like shape, and the first conductive circuit 13 is extended to the portion of this region. The first conductive circuit 13 of the projected region is used as a connection

terminals for connecting the circuit board 760 to external equipment (not shown). As a result, it becomes easier to bend as needed when mounting the circuit board 760 in electronic equipment.

Fig. 31 is a sectional view showing further another modification of the circuit board 1 of the first exemplary embodiment. In the circuit board 765 of this modification, plate member 920 is used instead of the base film 11, and a multilayer circuit is manufactured on the plate member 920 excluding a part of the region thereof. Further, another plate member 930 is laminated on the multilayer circuit to manufacture the circuit board 765.

Circuit 922 and through-electrode 924 are formed on the plate member 920. On one surface of the plate member 920 is formed a multilayer circuit by the same manufacturing method as in the first exemplary embodiment. After forming up to the third insulating layer 23, another plate member 930 is laminated in such manner that the through-electrode 934 of another plate member 930 aligns with the via 340. After that, the chip type electronic parts 6 being electronic parts such as resistors and capacitors are connected to the second conductive circuit 19 via the through-electrode 934 and the via 340. Also, the electronic part 810 is mounted on the plate member 920 as well. The circuit board 765 thus manufactured is a large-scale circuit board realized by integrating a multilayer circuit structure using conductive paste material and the plate members 920, 930. Further, the first conductive circuit 13 in the projected region

of the plate member 920 can be used as a connection terminals for connecting the circuit board to external equipment.

The circuit board 765 shown in Fig. 31 is configured in that the plate member 920 mounted with the electronic part 810 is projected, but it is also preferable to be configured in that another plate member 930 mounted with the chip type electronic part 6 is projected. Further, for mounting the electronic part 810 and chip type electronic part 6, it is preferable to mount the parts before forming or bonding the multilayer circuit.

Fig. 32 is a sectional view of circuit board 770 wherein the base film 11 is projected in the circuit board 755 shown in Fig. 29. That is, a multilayer circuit is formed on the base film 11 except the projected portion by using conductive paste material and insulating paste material. The structure is such that the plate member 900 is bonded to the region corresponding to the multilayer circuit. In this way, in the projected region, sufficient flexibility can be maintained because only the first conductive circuit 13 is formed on the base film 11. Accordingly, it is possible to bend the circuit board as needed when mounting in electronic equipment. And, it can be connected to other parts in the electronic equipment, using the first conductive circuit 13 formed on the region as connection terminals.

Fig. 33 is a sectional view showing the configuration further mounted with chip type electronic part 6 being an electronic part, wherein the base film 11 is projected and the first conductive circuit 13 and the first insulating layer 15 are formed on the projected region in the circuit board structure

shown in Fig. 29. Thus, unlike the shape of the plate member 900, it is preferable to make larger the base film 11, the multilayer circuit formed on the base film 11 and the electronic part mounted portion, or to make larger the plate member 900.

The exemplary embodiments of the present invention have been described above, but the present invention is not limited to the above exemplary embodiments, and it is possible to adopt various modifications.

For example, a circuit board with electronic parts built therein has been described in the present exemplary embodiment, but it is preferable to mount electronic parts on the surface of the circuit board instead of building them therein.

Also, in the above exemplary embodiments, examples of using conductive paste material including thermosetting resin, insulating paste material, resistant paste material, and dielectric paste material have been described, but the present invention is not limited to this. For example, it is preferable to use a paste material including resin having UV-setting property. Also, it is possible to use a material that naturally hardens at room temperatures provided that there arises no problem of hardening speeds.

Also, in the configuration shown in Fig. 27, it is described such that when metallic wiring is connected to the conductive circuit, the metallic wiring is formed by a depositing, plating or sputtering process. However, it is also preferable to form the whole of any one layer of a plurality of conductive circuits by means of a depositing, plating or sputtering process.

As the electronic parts built into the circuit board of the present invention, it is preferable to use chip type electronic parts such as resistors and capacitors, and multiple chip type electronic parts as well as the bare chip IC described above. Also, these electronic parts are not required to be formed with bumps. When conductive paste material is used, it is preferable to make an opening in the insulating layer in a position corresponding to the electrode of an electronic part and apply conductive past to the opening in order to connect the electrode terminals of the electronic part to the conductive circuit with the conductive material.

Also, the conductive circuit and the insulating layer are not limited to a fixed thickness, but preferable to be partially different in thickness. When conductive circuits and insulating layers which are not constant in thickness are placed one upon another, the conductive circuits and insulating layers then formed are not parallel with the base film, but this does not cause any particular problems. It is possible to manufacture a complicated circuit board of three-dimensional configuration by laminating layers which are not constant in thickness or not parallel with the base film. A circuit of three-dimensional configuration can be easily manufactured by a coating method including printing with use of a conductive paste material and insulating paste material.